Gender, Playstyle, and Learning: Constructing In-Game Measures of Playstyle

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ABSTRACT

Game play experiences unfold in response to player actions. In opened-ended games, "the game is different for every player" (Gee, 2005). Steinkuehler (2005) convincingly shows players construct their own experience within the structure of a game. Most play style taxonomies have been developed in the context of complex, massively multiplayer games. The taxonomies describe player types such as Bartle's (1996) ACHEIVER, EXPLORER, SOCIALIZER, and KILLER.

Less complex, less open-ended games are also likely to be played differently by different players. The range of possible play styles is more limited than with open ended games, but variations almost certainly do occur. Our particular interest is play style in educational games. Are there different player taxonomies? If so, does play style impact learning from a learning game?

Our presentation compares research findings about play style and player types in commercial games and considers implications for educational game play.

Prior research on play style has focused on in-game behavior. Sometimes male-female differences in play style are compared. Observational studies of game play suggest boys rush to beat the game, while girls are more interested in exploring (Klawe, Inkpen, Philllips, Upitis, and Rubin, 2002, Laurel, 2001). Initial playtesting of our evolution learning game, Life Preservers, showed extreme gender differences in how players approached the game, how long they took to play, and their final scores.

Aside from gender comparisons, player characteristics outside of the game have not been linked to in-game play style. We propose and are in the process of studying a set of personality constructs which may be associated with different play styles.

With National Science Foundation funding we are beginning a large project to address issues of play style, gender, personality, and learning from games. We designed Life Preservers, a science learning game to teach middle school and high school national science standards about evolution. A key goal of the game design was to allow for achievement and exploration play patterns. Speed of play is neither rewarded nor punished. Mistakes are "forgiven" in that players can keep trying until they get an answer right. The game does keep track of and display number wrong to motivate and reward achievement, but does not prevent anyone from getting to each round and level.

We collected preliminary survey and playstyle data from volunteer college students to validate and improve study methodology and in-game play style data measures, in preparation for a large national study. Participants first completed a pre-game survey measuring personality (using an adaptation of the NEO Big Five Personality Scale), gender, gender schema, and prior game experience. They next played the online game which collected detailed data (256 variables) related to play pattern. After the game, participants completed a post-game survey about science knowledge and reactions to the game.

The preliminary data provides proof of concept. In-game data collection reveals highly varied play behavior, even in the context of a close-ended educational game. The in-game measures of play style are described and results of each measure are presented. The individual play style variable are linked to a proposed learning game play style taxonomy.

RATIONALE

Hopefully seriously fun serious games for learning will soon be widely used to enhance and perhaps transform K-12 and college education. Kids' deep engagement in games and the hours they spend learning how to play complex games tantalize educators who want to tap into that energy. Growing evidence of perceptual, cognitive, and social benefits of playing commercial games (Gee, 2003; Johnson, 2005) furthers our hopes for games made specifically for learning.

Predicting Which Learners Will Benefit Most

Games for learning are not likely to benefit all learners equally. Those who benefit the most from games for learning will not necessarily be the students who today get the best grades in school. Logic predicts (though research has not proved) those likely to benefit most from a learning game would be students who:

1. are experienced gamers
2. love to play games
3. enjoy using computers
4. are adapt at the forms of interaction (such as spatial navigation, fast responses, shooting at or dodging threats) required to play the game
5. are interested in the learning subject matter the game is about
6. are interested in the game's back story and themes
7. Competitive students also might benefit more from learning games in which play is driven by earning points and winning than their less competitive peers.

Individual students of either gender may be prime candidates to benefit from learning games, but along all seven predictors many research studies show that males, on average, will be in a significantly stronger position to benefit from games for learning than females. (For example, see AAUW 1991 and 2000; Cassell & Jenkins, 1998; Laurel, 2001; and Chu, Heeter, Egidio, & Mishra, 2004) The disparity will be strongest if games for learning are designed to emulate the male-oriented themes, play patterns, and content of commercial games today without accommodating gender differences.

Play Style Taxonomies

Play style is a behavioral trait that may influence learning from learning games. Game play experiences unfold in response to player actions. In opened-ended games, "the game is different for every player" (Gee, 2005). Steinkuehler convincingly shows players construct their own experience within the structure of a game. "…The line between media consumption (playing games) and production (constructing personalized experiences from those games) is very much blurred."

MMOG play styles have been classified by Bartle, Yee, and Steinkuehler. Lazarro, and Klawe looked outside of MMOGs at casual and learning games. Bartle (1996) developed the original player classification schema, dividing players of the MUD, Lambda MU, into a quadrant of ACHIEVERS, EXPLORERS, KILLERS, and SOCIALIZERS. Achievers and Explorers are opposite ends of one axis, acting on or interacting with the game world. Killers and Socializers define the extremes of the second, perpendicular axis, acting on or interacting with the other players.. The implication was players exhibit a single, consistent, persistent play style. The Achiever-Socializer axis applies well to single player learning games. Achievers focus on advancing their avatars and game progress, while explorers seek to understand the game world and mechanics of the game.

Yee (2005, in press) surveyed 30,000 players of MMORPGs about their motivations for playing. He found five motivation factors: Achievement, Relationship, Immersion, Escapism and Manipulation. Most of Yee's respondents (85%) were male. Male players were more often driven by Achievement and Manipulation factors. Female players were more driven by the Relationship factor. Despite age and motivational differences, males and females reported the same level of enjoyment and derived the same emotional salience and impact from playing. It seems counterintuitive, but payer motivation did not seem to effect enjoyment.

Across 2 years of participant observation cognitive ethnography, Steinkuehler (2005) studied eight *Lineage II* players' complex and nuanced views of their own and their gamemates' styles of play. She discovered "gamers categorize themselves and other gamers along multiple axes, shaped and constrained not only by the game's *design* but also and equally by broader *sociocultural constructs*, such as aggressiveness, expertise, and willingness to take risks. The two most predominant axes were "social interdependence versus social dependence" and "play versus efficiency." Efficiency-oriented players are very determined to achieve and optimally advance in the game without wasting time or resources. Play oriented goals leave room for exploration whether it contributes to advancement or not. Both Yee and Steinkuehler expected players to engage in more than a single style of play

Games for learning can be multiplayer or even massively multiplayer, but MMOGs are expensive to create, complex to manage, and don't fit easily into the structure of traditional classrooms. A more frequent learning game genre in the near future will be single player, easy to use games that can be learned and played within a single class period. Even a short, simple game requires players to construct a personal experience, potentially evoking alternate play styles, albeit within much narrower boundaries. MMOG player types suggest that even within single player games for learning we will find explorers and achievers, those who play efficiently to win and those who play in less focused ways, just to play.

Lazarro (2004), president of XEO Design, conducts playtests for corporate clients. At the March 2005 Game Developers Conference she presented an elaboration of her 2004 white paper, "Why We Play Games: 4 Keys to More Emotion." She studied 30 gamers including some hardcore and some casual players. She recorded 2000 hours of facial expression during game play in the players' natural game play setting. Lazarro created 12 models of player experience looking at how games create emotion. Her analysis identified four key motivations for game play: Hard Fun, Easy Fun, Altered States, and the People Factor. She distinguished casual gamers and core gamers. Casual gamers are similar to explorers -- they play for the joy of playing. They are less tolerant of frustration and less experienced. Core gamers are the achievers. They play to beat the game. People Factor players are similar to Socializers. They play as a reason to be with people. Altered State players play to change something about their internal emotional or mental state – to relieve boredom, for stress relief, to get healthy or learn. All of her subjects were adult. The majority were male. None of the games her subjects played were learning games.

Klawe and colleagues observed 10,000 children playing various video and computer games at Science World computer games museum exhibit hall (Klawe, Inkpen, Phillips, Upitis, & Rubin, 2002).. Among other observations, they concluded boys are more interested in completing or winning the game, trying to finish in the shortest time possible. Girls take a more exploratory approach.

Personality and Playstyle

Uses and gratifications research links anticipated effects (gratifications) with media consumption choices (uses((Palmgren, P., Wenner, L.A., & Rosengren, K.E., 1985). Sherry (2001) tried to measure relationships between media gratifications sought with models of underlying personality. In his review of research on personality factors and computer game choice, Klimmt (in press) points out the need to include skills and competencies in addition to individual needs in considering game choice motivations. Competencies and skills also likely impact playstyle. Lack of skill may restrict players to a particular familiar playstyle.

Klimmt reviews two studies that looked for relationships between global dispositions and computer game choices – specifically, extroversion, neuroticism, and psychoticism were not significantly related to game preferences (Nelson and Carlson, 1985 and Kestenbaum and Weinsten, 1984, in Klimmt, in press). Klimmt cautions that personality researchers often discover a general predisposition does not necessarily translate into particular behaviors.

Playstyle taxonomies have not yet been linked through empirical research to personality traits. Personality factors closely parallel playstyle taxonomies. Klimmt and others may be correct in predictiong, these general dispositions will prove to be unrelated to game play. However the parallels between recognized personality factors and play style taxonomies are close enough to warrant testing.

Costa & McCrea (1995) describe the NEO five factor personality markers:

- **Neuroticism** (Anxiety, Hostility, Depression, Self-Consciousness, Impulsiveness, Vulnerability)
- **Extraversion** (Warmth, Gregariousness, Assertiveness, Activity, Excitement-Seeking, Positive Emotions)
- **Openness to Experience** (Fantasy, Aesthetics, Feelings, Actions, Ideas, Values)
- **Agreeableness** (Trust, Modesty, Compliance, Altruism, Straightforwardness, Tender-Mindedness)
- **Conscientiousness** (Competence, Self-Discipline, Achievement-Striving, Dutifulness, Order, Deliberation)

Many of the NEO Big-Five Personality factors map closely with playstyle taxonomies. The chart below proposes parallels between playstyle taxonomies and the personality markers.

Bartle	Klawe et al.	Lazarro	Yee	Steinkuehler	**NEO Personality Markers**
		Altered States	Escapism		**(alleviating) Neuroticism**
Socializers		People Factor	Relationship	Social Independence	**Extraversion**
Explorers	Playing	Casual Gamers	Immersion	Play	**Openness to Experience**
(reversed) Killers		(more People Factor)	(reversed) Manipulation	Social Interdependence	**Agreeableness**
Achievers	Winning	Core Gamers	Achievement	Efficiency	**Conscientiousness**

Conscientiousness is the least good fit with play style taxonomies reviewed here. None of the five personality markers overlap very directly with achievement and competition. The other markers do correspond with expected play styles, but conscientiousness does not. For the current study, the 50 question NEO scale was adapted for middle school classroom use. Conscientiousness was replaced with Competitiveness to more closely parallel anticipated playstyles. Eight instead of 10 questions were used, removing 2 questions from each scale least relevant to children. Scales were renamed to be consistent with playstyle taxonomies: Anxious, Social, Explorer, Agreeable, and Competitive.

Our research looks at gender as a central factor influencing game behavior and attitudes. Some gender differences related to games may be biological. Others are cultural. Bem (1976) pioneered the idea of measuring androgyny and gender roles, developing a sex role inventory. Her more recent work introduces gender schema theory (Bem, 1985) to explain how children are socialized into gender-specific roles In addition to looking at the relationship of gender, play style, and learning we will also include gender schema scales, to enable us to compare the impact of gender schema expectations with the impact of biological gender. Ten items in the pretest assess the rigidity of expectations about male gender schema (what males are and are not expected to be like) and 10 ask about extreme beliefs related to female gender schema are included in the pretest survey.

Play Style and Learning in Learning Games

Research has not yet looked at the relationship between play style and learning from a learning game. Will efficient players learn more, or will their focus rushing to win get in the way of the learning content? Will explorers learn more, or does their less focused play style result in less engagement and less attention to all aspects of the game?

Is there a difference in how much males and females learn from the same learning game? Which predicts learning outcomes better, play style, personality, gender, or gender schema?

In-Game Measurement of Play Style and Learning

With National Science Foundation funding we designed Life Preservers, a science learning game to teach middle school and high school national science standards about evolution. A key goal of the game design was to allow for both achievement and exploration play patterns. Speed of play is neither rewarded nor punished. Mistakes are “forgiven” in that players can keep trying until they get an answer right. The game does keep track of and display number wrong to motivate and reward achievement, but does not prevent anyone from moving forward to the next round and level. Playtesting helped us refine game play and story to a point where the current version of the game (Version 50) appeals to and engages girls.

We collected online survey data and gathered playstyle data within the game during play in a preliminary study of 20 college students. The preliminary study prepare us for a major, large scale high school student study. Participants first completed a pre-game online survey measuring personality (using an adaptation of the NEO Big Five Personality Scale), gender, gender schema, and prior science and game experience. They next played the online game which collected detailed data (256 variables) related to play pattern, and after the game, completed the final online survey questions to assess emotional reactions to the game and to measure science learning outcomes.

Previous play style taxonomies have relied on personal experiences of the researcher, player observation, surveys, analysis of facial expression. With the exception of Klawe, taxonomies are based on commercial and not educational games. Our preliminary analysis is a first attempt to define, collect and interpret play style behaviors based on data collected by the game during game play. Our study is also an attempt to define meaningful play behaviors in the rather narrow confines of a short, simple educational games. Do measurable, meaningful differences in play patterns occur?

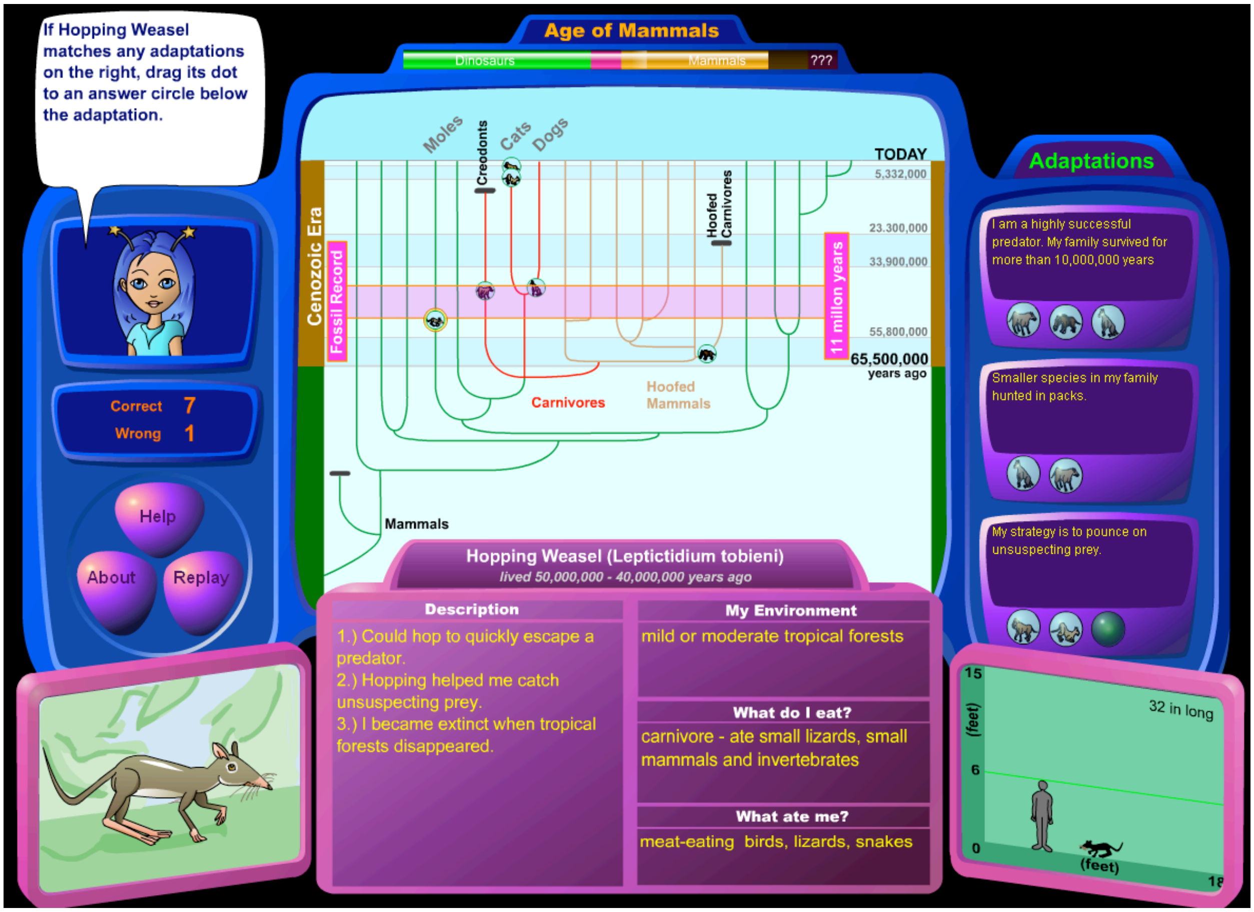
Introduction to Life Preservers

We originally hypothesized that because of gender differences in play style, girls would learn more than boys from the same learning game, particularly if the game allowed for exploration beyond what was required to win. Period research suggests boys will rush to beat the game, and girls will play more slowly, exploring and perhaps learning more. On the other hand, slower, less focused play may reflect less engagement and be associated with less rather than more learning.

To make these kinds of outcomes testable, Life Preservers game play includes more content than is necessary to play and win the game. The game includes a database of information about 11 earth critters plus 2 invading alien species in the Age of Dinosaurs and 26 earth critters plus 2 new invading alien species in the Age of Mammals. There are 10 rounds of play with 3 “adaptation challenges” per round.

Although game play essentially involves answering questions, the pedagogy is more complex than a simple trivia game. Learners explore a carefully selected content domain (part of the Tree of Life containing featured critters chosen to extemplify learning concent). They are guided to answer questions in each round that guide them to think about key concepts in evolution. Each round is reinforced by a narrated, animated cut scene that reiterates the key learning concepts.

In the main interface, three adaptation challenges appear along the right side. The tree of life for the age of mammals appears in the middle in the example below. Six critter dots represent the animals in play for this round. Clicking on a critter dot opens the electronic data at the bottom, including a drawing of the animal, graphical size comparison to a 6 foot human, and interesting, relevant details about the critter, its environment, what it eats, and what eats it.



The important learning in the game is actually the questions, NOT the answers. Today's close adherence to teaching what will be on standardized tests means only concepts appearing in national and state standards matter. Thus, that the first bird adapted from therapod dinosaurs around 150 million years ago is not relevant, but "the basic idea of biological evolution is that present day species developed from earlier distantly different species" is on the test.

Vygotsky believed social interactions "create our cognitive structures and social learning" (Palincsar, 1988). Higher mental processes are co-constructed during shared activities. Piaget sees social interaction as creating disequilibrium, offering input that challenges existing beliefs and forces learners to either assimilate consistent ideas or accommodate inconsistent ideas by adapting their cognitive schemas. The Life Preservers game acts as a good teacher, guiding learners to think about questions of evolution and adaptation in a carefully designed order. Far more is available to be learned than just the answer to the specific questions, but by following the guided train of thought, learners will become accustomed to new ways of thinking about species and how they are adapted to their environment.

Alien Invasions

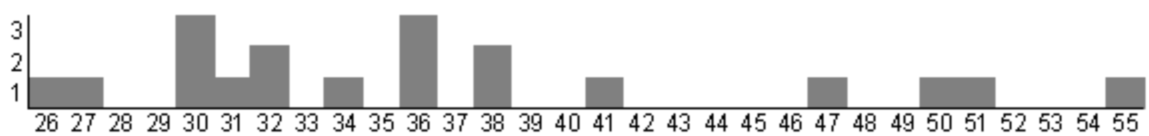
Adding invasive, non-native species to an ecosystem is the second leading cause of extinction (a distant second to the leading cause, climate change). In Life Preservers, the player/learner tries to protect Earth from autopilot ships filled with alien species whose presence on Earth could change the entire evolution of life on the planet. This twist makes the story more engaging. Unlike other rounds, alien invasion rounds do not have right or wrong answers. All of the critters encountered in the era appear on the game board. Players choose up to four critters most likely to be impacted by each alien, then choose which alien to block. Players think through possible consequences for each earth critter, and make their own choices. The alien invasion rounds apply pedagogy approaching the ideal of constructivism, involving the learner/player in making sense of what they observe and manipulate. The learner/players construct knowledge, drawing their own conclusions.

Variables and Preliminary Results

50 students enrolled in a university horticulture class were invited to test Life Preservers. 30 were able to log in, and 20 completed the pre-survey, game, and post-survey. Their data provides a pretest of our data collection approaches, prior to full scale collection from approximately 600 high school and college students. Our test students turned out to be 60% female. None of the participants including the males are avid gamers.

Time Needed to Complete the Game (Efficiency and Exploration)

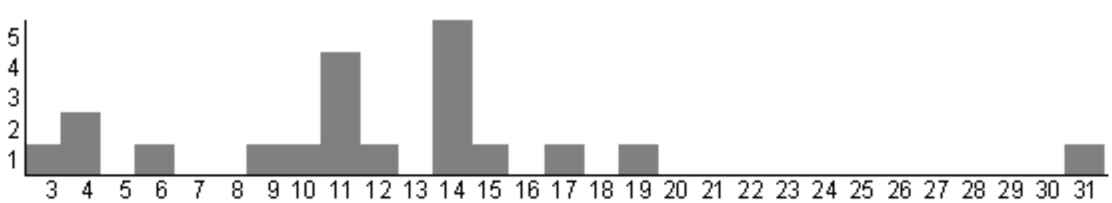
Total game play minutes may be a measure of efficiency and achievement orientation. If, as Klawe et al. report, boys “rush to beat the game,” then duration of play should be an important measure to compare male and female play. Across 19 college students, time spent playing ranged from 26 minutes to 55 minutes. Slightly less than two thirds (63%) played for between 30 and 38 minutes, and 21% played for 47 minutes or more. A limitation of the pretest is that the sample size is too small to detect any except very large gender differences.



The diverse span of minutes to complete the game across the 19 players is somewhat surprising in a game with highly restricted play, 9 rounds, and a fixed number of matches. The result demonstrates how much players create their own experiences, even in the restricted play space of an educational game. Does less time reflect efficiency and achievement? Does more time reflect exploration? How does time spent relate to learning from the game?

Number Wrong (Efficiency and, Perhaps, Anxiety)

All players got the same number right. To accommodate a sense of competition and to motivate play, Life Preservers keeps track of the number wrong as well as the number right. Both scores are displayed onscreen at all times. Number wrong is a measure of how well players performed. Ten percent of our pretest players did very well, getting six or fewer matches wrong. Thirty-five percent made between 9 and 12 incorrect choices. Thirty percent were wrong on 14 or 15 tries. Ten percent got between 17 and 19 wrong. And one person amassed 31 incorrect choices.

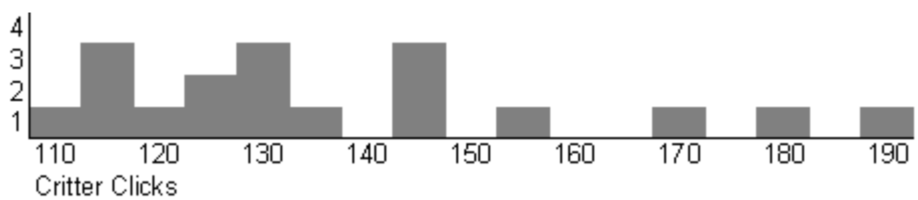


The best score obtained to date was outside of the scope of this preliminary study. A 5th grade girl spent one hour and 20 minutes playing. She did not want to make a mistake. She read carefully, thought through every answer, and got fewer wrong than anyone else who has played. Her only two errors turned out to be mistakes in the game. She was right and we were wrong. The college students made more mistakes than our high school playtesters. Apparently they did not feel pressure to be perfect, and preferred to guess more quickly rather than perform perfectly. According to conceptualizations of an achiever, achievers would be players who are motivated to commit fewer matching errors and thus achieve low wrong scores. Are people who score high on the anxiety scale worried about making mistakes? Do achievement-oriented or anxiety-oriented personality markers result in better performance in the game? Does getting lots of answers wrong result in less learning?

Critter Clicks (Exploration and Efficiency)

Steinkuehler would probably predict that her efficiency oriented players would try to complete the game with as few wrong matches as possible, in the least number of mouse clicks, in the shortest time. The minimum number of clicks on critter dots, if every answer was known without having to make comparisons, would be 88. (That is how many correct matches must be made to complete the game.) The game is programmed to record total number of clicks on each critter, as well as total time each critter's information brochure is displayed at the bottom of the screen.

The number of critter clicks observed far exceeded the minimum of 88. Two thirds of players clustered between 110 and 135 clicks; the remaining 44% clicked more, as much as nearly 190 clicks.



For some players may been interested to explore the ancient critters. Much more content than is needed to complete the game was provided for each critter. The chart below lists the 11 critters from Level 1, the Age of Dinosaurs. Column 2 is how many seconds the brochure was onscreen. Column 3 is total number of times the critter dot was clicked. Column 4 is the average number of seconds each critter's brochure was on screen per round it appeared in. Some critters showed up in only 2 rounds. Others appeared in as many as 5 rounds. Column 4 adjusts for frequency of appearance.

Age of Dinosaurs (EARTH CRITTERS)	time spent on brochure	clicks on critter dot	average time/round
Leatherback Turtle (Dermochelys coriacea)	99	6.6	25
Flying Reptile (Pteranodon)	79	5.1	26
Swimming Reptile (Icthyosaur)	61	4.1	20
First Bird (Archaeopteryx)	56	6.5	14
Terror Bird (Phorusrhacos)	34	3.6	17
Ancient Penguin (Palaeeudyptes antarcticus)	30	3	15
Small Dinosaur (Scipionyx samniticus)	28	2.4	14
Tyrannosaurus Rex (Tyrannosaurus rex)	26	3	9
Stegosaurus (Stegosaurus)	25	3	13
Incredible Giant Bird (Teratornis)	23	2	12
Triceratops (Triceratops)	23	2.9	12

The distribution of clicks and time spent differs greatly across the 11 critters in the age of dinosuars. Leatherback turtles and flying reptiles received the most attention (more than a minute), while Triceratops, Stegosaurus, T-Rex, and the Teratornis bird were viewed for 25 seconds or less. There is a tendency for players to spend less time on familiar critters, guessing rather than reading. The numbers in the table are averages which mask much larger variations by individual players.

The two invading aliens at this level were each looked at for around 25 seconds. Players clicked on the critter dots to go back and check at least once and sometimes more. Seventy-five percent of the players diverted the hoofed fox, allowing the dragons to populate Earth. Fox was the wiser choice to divert. It would have caused more damage to Earth's ecosystem. Choosing to divert the fox is a more important measure of smart play than sampling getting the matching questions correct. It reflects understanding and it has in-game consequences for our planet.

Age of Dinosaurs (ALIENS)	time spent	clicks	diverted
Hoofed Fox (Centauran Hoofed Fox)	26	2.1	25%
Flying Dragon (Denebian Dracosaurus)	23	2.5	75%

The next chart shows the 24 critters from the Age of Mammals. Humans and early monkeys are viewed for a total of 15 seconds each, not nearly enough time to read what was written about them. The seven least viewed critters are from the primate branch, most likely the most familiar of any of the branches. Players who do spend more time on familiar critters would not be efficient. Perhaps a measure should be constructed of time spend on familiar, little accessed critters.

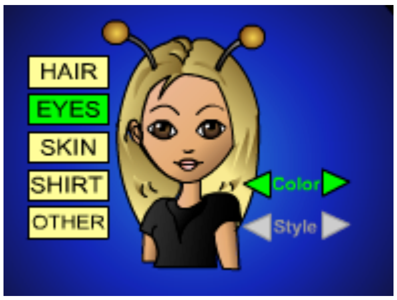
Age of Mammals (EARTH CRITTERS)	time spent on brochure	clicks on critter dot	average time/round
Hyenatooth Creodont (Hyaenodon gigas)	65	7.4	22
Hoofed Meat-eater (Andrewsarchus)	60	5.6	20
Pouched Mammal (Deltatheridium)	42	4.7	21
Gigantic Elephant (Deinotherium bozasi)	41	4.2	14
Giant Antlers (Megaloceros giganteus)	40	3.9	13
Ancient Rhino (Paraceratherium)	38	4.5	13
First Horse (Eohippus)	36	4.1	12
Wooly Mammoth (Mammuthus primigenius)	34	3.8	11
Shrew-like Mammal (Eozostrodon)	33	3.8	17
Giant Armadillo (Doedicurus clavicaudatus)	30	3.4	15
Walking Whale (Ambulocetus natans)	30	3.7	15
Bear-dog (Amphicyonid)	29	3.2	15
Wooly Rhino (Coelodonta antiquatatis)	29	3.9	10
Hopping Weasel (Leptictidium tobieni)	26	3.7	13
Saber Tooth Cat (Smilodon populator)	26	2.8	13
Spear-tooth Whale (Dorudon atrox)	26	3.2	13
Terrible Cat (Dinofelis barlowi)	25	3	13
Gorilla (Gorilla)	24	2.4	12
Giant Guinea Pig (Goya)	23	2	12
Early Hominid (Australopithecus afarensis)	22	2.3	11
Squirrel-sized Primate (Altiatlasius)	20	2.7	10
Early Nocturnal Primate (Godinotia neglecta)	18	2.9	9
Human (Homo sapiens)	15	1.8	8
Early Monkey (Apidium moustafai)	15	2.3	8

Most players also made a poor choice of which alien to let in to the Age of Mammals. Fifty-five percent allowed the Arcturan Tree-Eating Crab to land. The crab destroyed primate tree habitates, totally disrupted evolution of the primate branch,. The result was humans never evolved from earlier primates.

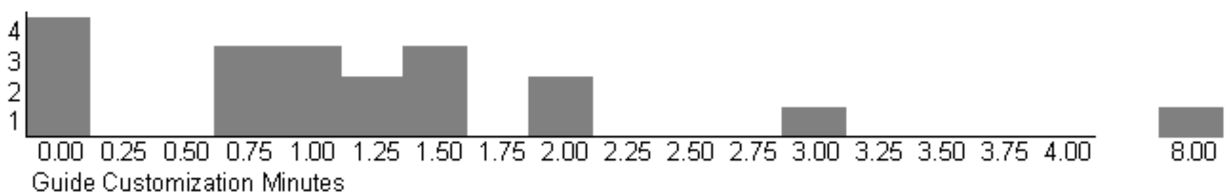
Age of Mammals (ALIENS)	time spent	clicks	diverted
Arcturan Minigoat, swarming minigoat	29	2.7	55%
Andromedan Tree Crab, tree-eating crab	26	2.3	45%

Guide Customization (another opportunity for exploration

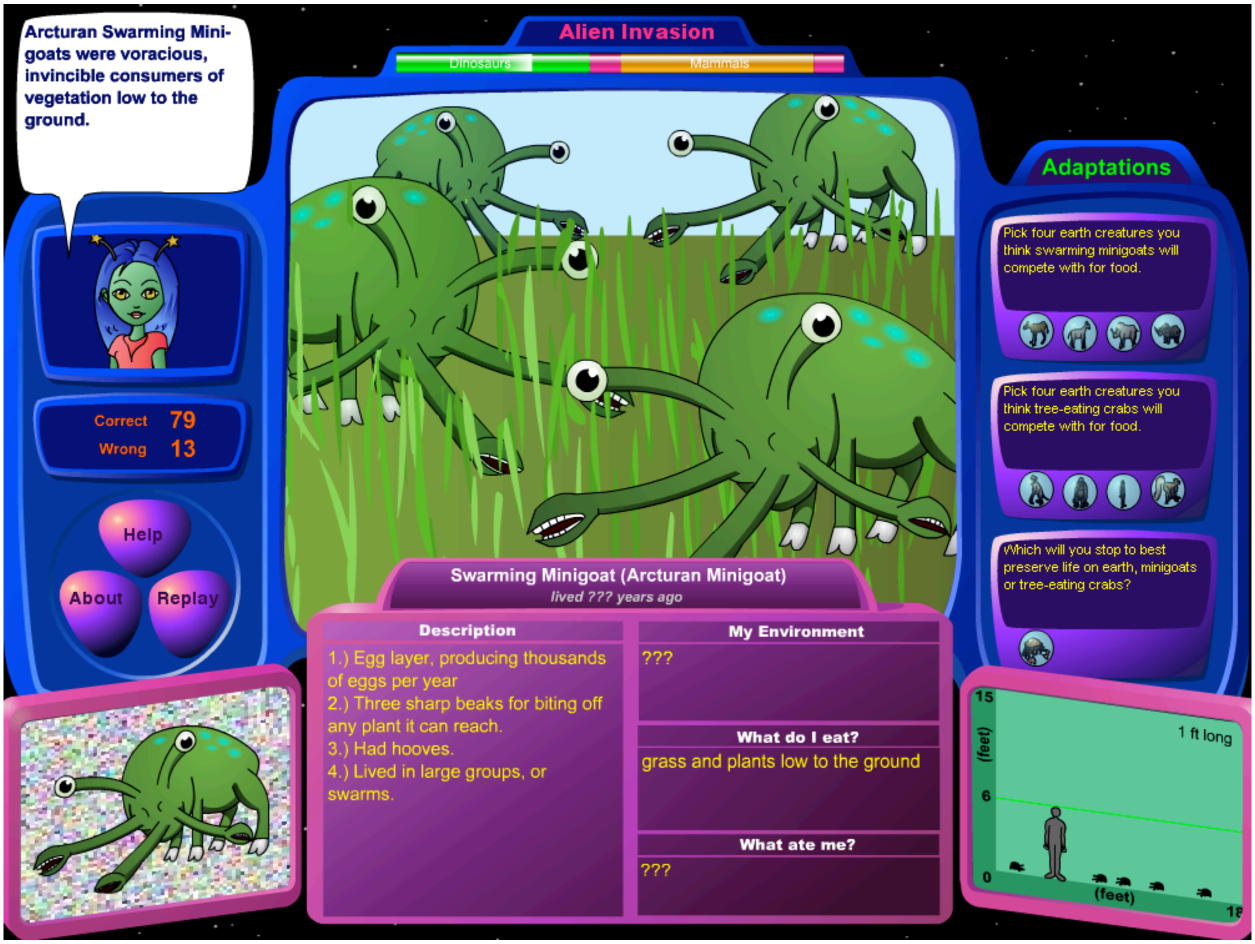
At the beginning of the game, players are invited to customize the guide. Hair, eyes, skin, shirt, and other (antennae) are customizable. Customization of avatars and NPCs is often a component of games incouding educational games. Efficient players might not feel a need for customization, but explorers might spend time customizing.



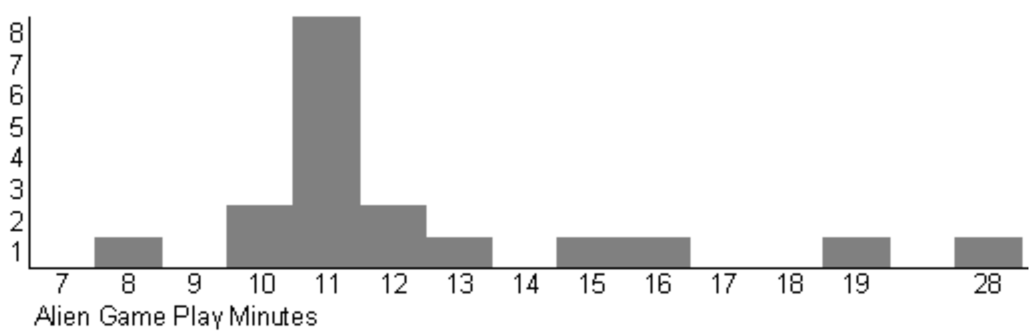
Four players did not bother to customize the guide at all. The numbers in the table below are minutes expressed as decimals rather than minutes and seconds. Most players spent between one minute and a minute and a half customizing the guide. One took 8 minutes, one spent 3 and another 2 minutes.Once again, wide variation on play styles are apparent.



Alien Invasion Rounds



The alien invasion rounds are more free form than the age of dinosaur and age of mammal rounds. . There are a few wrong matches but many possible correct matches. Players can take their time thinking about the impact each alien might have on every creature they have encountered in the game. Players pick four critters each alien would eat (in Level 1) or compete with for food (in Level 2), then choose which of the two invading alien species to divert. Achievers could go quickly. Explorers could go slowly. Time spent in the alien rounds is of a different flavor than overall game time.



Most players spent between 10 and 12 minutes across both alien invasions combined. Some took much longer.

Systematic Play

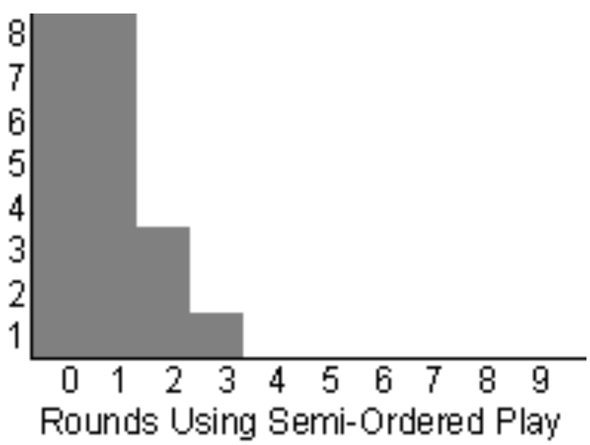
Each of the nine rounds of play in Life Preservers includes three adaptation challenges with between one and four correct matches per challenge.

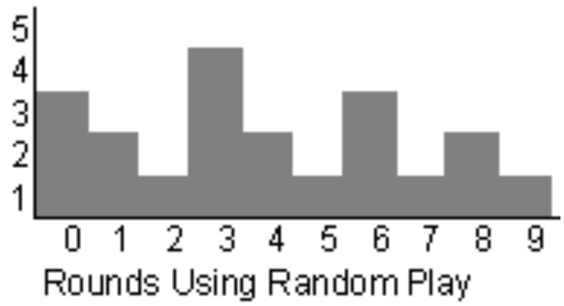
It was possible to play systematically, matching every dot for that adaptation before moving on to another adaptation. Or, a semi-systemic strategy could be adopted, completing an adaptation but then jumping out of order to a different adaptation. Or one could answer in a seemingly random order, hopping from question to question and back.

Each round was coded as either ordered play (each challenge completed, followed by the one below), semi-ordered (the adaptations not in order, but complete within an adaptation before moving to another), or random (jumping from adaptation to adaptation frequently). The three charts below show the number of rounds of ordered play, semi-ordered play, and random play rounds by frequency of player (n=20 players)

The systematic and random behaviors defined here are idiosyncratic to Life Preservers. The observations demonstrate one way to think about play patterns related to our game. Other game-specific measures would be developed for different games.

Ten percent of game players never used an ordered play strategy for any of their nine rounds. Five percent always used an ordered approach. Forty percent used random strategy more than half of the time; 35% either never used random play or did so at most did so for a single round. The remaining 25% employed a mix of random, ordered play, and semi-ordered play.





Not surprisingly, random play and ordered play have a negative correlation of -.955, with a significant approaching .000.

The 20 person sample does not include gamers. 25% say they play video arcade games, 25% play handheld games, 50% play console games, and 80% play computer games. However, combining all forms of games, 25% do not play at all in a typical week. Sixty percent play for less than two hours, and 15% play for 2 or more hours.

30% of the players were male. One male hated to play games. Two males loved to play, 2 liked to play, and 2 were neutral about playing. Among the 14 female volunteer players, 8% loved to play games, 17% liked to play, 42% were neutral, and one third did not like to play games.

Males' self-estimated game play skill was significantly higher than females self-rated skill. (3.75 for females, 2.75 for males, where 1 is very skilled and 5 is not skilled at all). (f=.122, p-.041, df=19). Males also claimed to already know significantly more about dinosaurs and about life on earth before humans than females claimed to know.

Despite the small but significant gender differences in game play enjoyment, amount of game play, and game play skill, few gender differences in Life Preserver play were observed. Females enjoyed playing Life Preservers significantly more than males did (3.82 compared to 3.0), F=.147, p=.048, df=19). With our small pretest sample size, comparisons of game play minutes, number of wrong matches, number of critter clicks, time spent customizing the game were not significantly different.

Survey Scales

The final tables show preliminary data for the scales and survey data. With our very small sample and lack of gamers, few significant results have emerged, which is to be expected.

Expert and Non-expert Players

The pretest survey asked respondents how skillful they were at playing games. The table below compares means for a variety of play pattern variables among those who rated their generic game play skill as quite skilled, neutral, not skilled, and not at all skilled. The three not-at-all-skilled gamers are particularly anomalous. They completed Life Preservers fastest, made far fewer wrong matches than the skilled players, used fewer critter clicks to complete the game, enjoyed playing Life Preservers more than skilled or neutral players, and more consistently made smart choices about which aliens to divert to best preserve life on Earth. Not at all skilled gamers very rarely completed the adaptation challenges in order, apparently going critter by critter rather than adaptation by adaptation. Skilled and neutral players also used random patterns, but they made many mistakes, unlike the not at all skilled players.

	skilled	neutral	not skilled	not at all skilled	p
minutes to complete game	35	37	40	33	0.591
number of wrong matches	18	9	11	10	**0.058**
random play rounds	4.7	4.5	2	6.3	**0.102**
non-alien critter clicks	141	136	144	124	0.694
dino time	14	16	17	14	0.729
mammal time	21	21	24	20	0.620
alien time	12	13	14	11	0.591
dragon	17%	25%	29%	33%	0.957
goat	17%	25%	57%	100%	**0.082**
enjoyed LP	2.8	3	4.3	3.5	**0.007**
customization time	54	102	118	58	0.724
n	6	4	7	3	

Skilled gamers also showed peculiar results. They made more wrong matches than any other group and they made the worst choices of which alien to divert. They enjoyed Life Preservers the least. Life Preservers appealed more to unskilled gamers.

The next table shows correlations between the explorer and competition personality factors with many of the in-game measures (game time through random rounds) plus survey post test questions about enjoyment of Life Preservers, how skillfully they thought they played, and whether they thought they learned very much.

	game time	mistakes	critter clicks	customiza tio time	orderly rounds	random rounds	enjoyment	skill	learning
explore									
R	-0.279	0.377	0.065	0.001	-0.221	0.270	-0.019	-0.224	0.213
p	0.234	**0.102**	0.785	0.998	0.348	0.249	0.939	0.357	0.397
compete									
R	0.133	0.044	0.140	-0.142	-0.353	0.300	-0.128	-0.230	0.036
p	0.575	0.855	0.556	0.551	**0.127**	**0.198**	0.601	0.344	0.887

Explorers tended to make more mistakes. Competitors tended to be less orderly and more random in their play. (Perhaps random is a more efficient strategy in this game.)

Regarding gender schema, females had significantly less rigid expectations of how males are supposed to behave. The differences for female gender schema were not significant.

	females	males	F	p	df
boy gender role schema	4.48	4.89	1.02	0.036	18
girl gender role schema	4.69	4.83	3.539	0.541	18
	(1=not at all accurate, 7=extremely accurate)				
	n=14	n=6			

Players with more rigid male gender schemas and more rigid female gender schemas made more mistakes in the game.

Being female was significantly correlated with less rigid male gender schema, but unrelated to female gender schema.

Mistakes	Boy Gender Role Schema	Girl Gender Role Schema	Gender
R	0.529	0.507	0.295
p	**0.016**	**0.022**	0.207
n	19	19	
Gender (F=1 , M=2)			
R	0.472	0.145	
p	**0.036**	0.541	
n	19	19	

PREDICTING LEARNING

Learning was measured in the online post-game survey using 25 test items drawn from middle and high school textbooks and a selection of example national science standardized test questions about evolution and adaptation. Learning scores among study participants ranged from 11 to 23 (from a maximum of 25) with an average of 18.4.

A multiple regression analysis was run using in-game play style constructs and personality and gender schema scales to predict learning. The regression was significant (f=8.96, p=.024). Higher learning scores were associated with completing the game in less time, more critter clicks, less use of random play style, fewer incorrect matches, a more rigid male gender schema, a less rigid female gender schema, being an extravert, being anxious, being an explorer, and diverting the hoofed fox. These results are not definitive. The sample size is too small and not the target audience for the game. Hopefully college students already know most or all of the concepts taught in the game. We don't know whether the learning scale is measuring prior knowledge or learning from the game. The table is included to show how we hope to be able to link play style and learning.

Multiple Regression Coefficients Predicting Learning

	Beta	t	sig
(Constant)		5.694	.005
total game minutes	-1.941	**-7.113**	**.002**
critter clicks	2.522	**8.701**	**.001**
random play rounds	-.414	-3.452	**.026**
number wrong	-1.129	**-5.715**	**.005**
male gender schema	.445	2.504	**.067**
female gender schema	-1.248	**-6.073**	**.004**
extravert	1.085	**5.232**	**.006**
social	-.180	-1.442	.223
anxious	.938	**5.925**	**.004**
compete	-.322	-1.932	.126
explore	-.582	-2.837	**.047**
stopped tree crab	-.240	-1.919	.127
stopped hoofed fox	1.086	**7.315**	**.002**

NEXT STEPS

This pretest has been an important first step in our larger data collection process. We identified problems with the online data collection process. Out of 50 volunteer subjects, 43 students (86%) completed the online-pregame survey. Only 24 of them (56% of the original group) were either willing or able to follow the link to play the game. Of those, only 18 completed the post-game survey (36% of the original volunteer pool) All three online components pregame survey, game, and postgame survey were supposed to occur at one time, in a single session, with a single login. For future data collection we will divide the online experience into two distinct parts – the pretest, and the game plus short posttest. This will allow participants to divide the tasks across more than one day and should be easier to fit into high school class structures and hopefully achieve more compliance on the part of participants and network technology.

We plan to create five alternate versions of the game – plain vanilla (the default version pretested this week) and four slight differences intended to alter game goals and player behavior. The variations represent typical educational game designs. The results should be useful to educational game designers in making informed design decisions with an understanding of how those decisions could impact learning.

The measures we have in place will be used to compare these different flavors of the game, allowing us to draw conclusions about the impact of key design decisions for learning games.

MODIFICATION 1: Ambiguous number of correct matches

Currently in each round of Life Preservers, there are three adaptation challenges. Beneath each adaptation challenge, between 1 and 4 “answer circles” appear. The number of answer circles informs players how many right answers there are.

If we remove the hint of how many answers are expected, players will have to work harder to be sure they are not missing a correct answer. Currently the player has to fill all of the answer circles. To get through the game, you eventually have to get every answer correct. If the number of right answers were unknown, there could be correct answers, wrong answers, and missed answers. Would this version result in more learning? Would boys learn more this way because they are motivated by doing well in the game, or would both genders respond well?

MODIFICATION 2: Reward exploration.

Currently there is no explicit reward for time spent exploring the different critters. We could add a summary screen at the end of each level or each round reporting time spent exploring each critter from that age. There might even be some overall tracking of exploration completeness. Perhaps players earn badges for time spent on a critter.

Would this reinforce exploration rather than rushing to beat the game? Would girls and boys respond differently to this kind of reward?

MODIFICATION 3: Timed Play.
Girls say they do not like games which require fast reactions. Often this refers to twitch games requiring a rapid mouse or arrow reaction. Timed tasks may also be aversive to girls. Timed tasks are a common way for games to add challenge. If we add a timing factor to each round in the game, will girl’s learning and enjoyment suffer, or will it help engage all players in the experience? Evidence one way or the other would inform design of learning games.

MODIFICATION 4: Playing in pairs.

Games and gender research often mentions girls like social dimensions of games. Life Preservers is a single player game, but could easily be turned into a social experience by assigning kids to play in pairs. Same gender and mixed gender pairs could be compared with solo play learning. This has important implications for HOW games are integrated into the classroom.

This preliminary study presented here demonstrates that in-game data can be conceptualized, collected, and synthesized. We found wide variation in key play style-related variables which suggest that playstyles emerge even in the context of simple learning games. Our next steps include expanding data collection to a larger audience in the age groups for which the game was designed. Soon we will be able to look playstyle and personality as they relate to learning, gender, and gender schemas.

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